Specification

1. Title of the Invention

ION IRRADIATION METHOD

2. Claims

A method of irradiating ions characterized by comprising:

heating indium iodide (3) in vacuum to obtain gasified indium iodide;

introducing the gasified indium iodide into a discharge chamber (5);

decomposing the gasified indium iodide into ions by discharging, thereby producing indium ions; and

performing ionic irradiation by using the indium ions as an ion source.

3. The Detailed Description of the Invention

[Summary]

The present invention relates to an ion irradiation method, and more particularly, to an indium ion irradiation method.

An object of the present invention is to provide an ion irradiation method capable of easily and stably supplying indium ions and comprises:

heating indium iodide in vacuum to obtain gasified indium iodide;

introducing the gasified indium iodide into a discharge chamber;

decomposing the gasified indium iodide into ions by discharging, thereby producing indium ions; and

performing ionic irradiation by using the indium ions as an ion source.

[Field of the Invention]

The present invention relates to an ion irradiation method, and more particularly, to an indium ion irradiation method.

Recently, application of a semiconductor has been expanded to optical communications and microwave communications. Also, semiconductors other than silicon have been widely used. With this tendency, the number of types of impurity

elements to be introduced into semiconductors has been increased.

Of them, indium becomes an important impurity to be introduced into semiconductors.

[Prior Art]

Conventionally, an ion implantation method has been used as a means for selectively introducing indium into a semiconductor.

To ionize indium ions, indium alone must be heated in vacuum at a temperature of not lower than 1000°C to generate indium gas. The indium gas is introduced into a discharge chamber and decomposed by arc discharge to generate indium ions.

However, a commercially available ion implantation device does not usually have a heating means for raising the temperature of the ion source to not lower than 1000°C. This is because, when a general impurity such as arsenic (As) or antimony (Sb) is used, the temperature may be sufficient to raise about 800°C.

Alternatively, another ionization method for indium is known. In this method, Indium is placed in a discharge chamber, and indium atoms are tapped out by use of the sputtering function of an inert gas plasma, and then, ionized to generate indium ions.

However, this method supplies indium atoms physically by tapping out. As a natural consequence, it is principally impossible to obtain sufficient ion beam current, so that this method cannot be applied to a semiconductor manufacturing process in practice.

[Problems to be Solved by the Invention]

When indium is introduced into a semiconductor by a conventional ion implantation method, it is necessary to modify a commercially available ion implantation device generally used or specifically design a device having an ion source equipped with heating means capable of raising the temperature up to 1000°C or more. In addition, even if such a device is prepared, because of the high heating temperature, the device is easily broken. It is difficult to retain the ion beam for a long time.

The present invention is directed to an ion implantation method capable of easily and stably supplying indium ions by a commercially available ion implantation device generally used.

[Means for Solving the Problems]

The aforementioned problems can be solved by an ion irradiation method comprising

heating indium iodide 3 in vacuum to obtain gasified indium iodide;

introducing the gasified indium iodide into a discharge chamber 5;

decomposing the gasified indium iodide into ions by discharging, thereby producing indium ions, and

performing ionic irradiation by using the indium ions as an ion source.

[Operation]

The object of the present invention is to obtain a vapor pressure appropriate for performing ionization at a temperature of 1000°C or lower, more preferably, at a temperature of 300 to 500°C, continuously and over many hours by using an indium compound whose vapor pressure is higher than that of indium alone. Indium iodide gas can be effectively generated from indium iodide at a temperature from 300ºC to 500ºC, which can be easily controlled by a commercially available ion implantation device. The resultant indium iodide gas is introduced into a discharge chamber and decomposed to ions by discharging. In this manner, Indium ions can be generated stably over many hours and used as an ion source of the ion implantation device.

[Embodiments]

FIG. 1 is a schematic view of a part of an ion implantation device, an ion source, for illustrating an example of the present invention. Reference numeral 1 denotes a boron nitride cylinder, 2 a resistance heater, 3 indium iodide, 4 a carbon container, 5 a discharge chamber, 51 a tungsten filament, 52 a cathode, 53 an insulating portion, 54 an inert gas inlet, and 55 an ion ejection port.

A whole ion source is housed in a vacuum container (not shown).

Approximately 100 mg of Granular indium iodide 3 was placed in a carbon container 4, which is then placed in the nitride boron cylinder 1 surrounded by resistance heaters 2.

After the whole ion source is evacuated to a vacuum of about 2×10^{-6} Torr, the carbon container 4 containing indium iodide 3 is heated by the heater 3 for about 20 minutes to increase the temperature of the carbon container 4 to 100°C to 200°C. Thereafter, argon is introduced into the discharge chamber 5 from the inert gas inlet 54 to set a vacuum degree of 5×10^{-4} to 5×10^{-6} Torr and a voltage of about 25 kV is applied between the cathodes 52 to cause arc discharge. From this state, the current for the heater 2 is increased to set the temperature of carbon chamber 4 between 300°C to 500°C. Consequently, indium iodide 3 in the carbon chamber 4 is gasified. The gasified indium iodide is diffused in the discharge chamber 5 where an arc discharge is taking place and decomposed into ions by the arc discharge to generate indium ions.

Indium ions are ejected out of an ion ejection port 55. The ejected indium ions are taken out in accordance with a general beam taking out operation to obtain an indium ion current of 5 to 50 μA over one hour.

Ion implantation is performed by irradiating, for example, a GaAs substrate with indium ions.

Since indium chloride has a high vapor pressure and is gasified at a temperature of 1000°C or less, it is considered possible to ionize indium chloride by arc discharge. However, according to the experimental results, an extremely large vapor pressure was obtained at a temperature of 300°C or less, so that it was difficult to control indium chloride to supply an indium ion beam for a long time.

Furthermore, indium halides such as indium fluoride and indium bromide having a high vapor pressure have been investigated. However, each of them has a problem. It was found that Indium iodide is the most suitable.

In the foregoing, an ion implantation method using an embodiment of the present invention has been explained. The indium ions obtained by the present

invention may be used in accumulation of ion beam.

[Advantages of the invention]

As explained in the above, according to the present invention, indium ion beam can be obtained easily and stably by a general ion implantation device.

The present invention greatly contributes to production of a semiconductor device having indium introduced as an impurity.

4. Detailed Description of the Drawings

FIG. 1 is a view illustrating for an embodiment of the present invention where

1. Boron nitride cylinder,

2. Resistance heater

3. Indium iodide,

4. Carbon container,

5. Discharge chamber,

51. Tungsten filament,

52. Cathode,

53. Insulating portion,

54. Inert gas inlet, and

55. Ion ejection port.